Amanda Warner and Aubry Bell

Chapter 15

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Makeup of the Human Body

Cells of the Human Body

* Human body has millions of tiny cells. Cells differ in size, shape, and may contain special materials. Differences in characteristics make it possible for cells to perform particular jobs within the body.
* **Tissue-** A group of specialized cells working together to perform a specific function.
* Four major types of tissue:
  + Epithelial- covers exposed surfaces, lines internal passageways, chambers, and forms glands.
  + Connective- fills internal spaces, provides structural support for other tissues, transports materials within the body, and stores energy reserves.
  + Muscle- performs movement, generates heat to keep the body warm.
  + Nerve- uses electrical impulses to transport information in the body.

The Organ System

* 11 systems in the human body.
  + Integumentary system- covers and protects the body, regulates body temperature, and eliminates waste.
    - Ex: skin, hair, sweat glands, and nails.
  + Skeletal system- supports the body, provides protection to internal organs, stores minerals, and produces blood.
    - Ex: bones, cartilage, tendons, and ligaments.
  + Muscular system- allows the body parts to move, protects internal organs, and produces body heat.
    - The muscles.
  + Digestive system- digests and absorbs the food we eat.
    - Ex: mouth, esophagus, stomach, liver, and intestines.
  + Cardiovascular system- moves materials to cells, and carries away waste.
    - Ex: blood, heart, arteries, veins, and tiny blood vessels (capillaries)
  + Respiratory system- takes in oxygen, eliminates carbon dioxide.
    - Ex: nose, windpipe, larynx, bronchi, and lungs.
  + Urinary system- eliminates excess water, salt, and waste products from the body.
    - Ex: kidneys, ureters, urinary bladder, and urethra.
  + Nervous system- helps the body respond to stimuli.
    - Ex: nerves, brain, sensory organs, and spinal cord.
  + Reproductive system- affects sex characteristics, and enables production of offspring.
    - Ex: male penis, testes, the female vagina, uterus, and ovaries.
  + Endocrine system- various glands that produce chemicals that control and regulate body functions.
  + Lymphatic system- provides defense against infection and disease.
    - Ex: lymph, lymphatic vessels, lymphocytes, spleen, appendix, and lymphatic nodules.

Integumentary System

Functions of the Integumentary System

* The skin’s important functions:
  + Protects the body from harmful bacteria.
  + Prevents water and other liquids from entering the body.
  + Protects the inner parts of the body from injury.
* When the skin is injured, it can repair itself and regenerate new skin.
* Melanin and its function:
  + Melanin is a pigment in the skin
  + It’s function is to protect the skin from the sun’s rays.
  + People with large amounts of Melanin are dark, People with small amounts of Melanin are pale.
  + Melanin allows animals like chameleons to change colors.
* Many nerve endings give skin sensitivity to touch, pressure, pain, heat, and cold.
* The features of the skin that help the body remain alive and healthy include:
  + Sweat glands allow the escape of bodily wastes through sweat.
  + Each sweat gland has a tube that leads the seat to the surface of the skin.
  + Blood vessels surround each sweat gland.
  + Cells of the sweat glands filter; saltwater, minerals, and other waste products in the blood.
  + In warm environments sweat glands give off large amounts of sweat, which evaporates on the surface of the skin.
  + Water needs heat to evaporate; it takes this heat from the surface of the body, thus cooling the body.
* Oil glands are connected to the cells that produce hair. This oil helps keep hair from drying out, keeps skin elastic, and retards the growth of certain bacteria found on skin.
* When exposed to ultraviolet rays from sunlight, cells in the dermis convert carotene to Vitamin D.
  + Vitamin D aids in the absorption of calcium an phosphorus in the small intestine, into the blood stream.

Structure of skin

* The skin is an organ that covers and protects the body.
* The skin is the largest organ of the body.
  + Consists of two layers
    - Epidermis- thin outer layer.
    - Dermis- thick inner layer.

1. Epidermis:

* The outer cells are flat, scaly, and horny.
* The outer cells are constantly being shed or rubbed off as dead cells.
* If a spot on the skin is rubbed extensively, a large number of new cells will push to the surface and create a thick pocket of skin. This pocket is called a callous.
* The living cells of the epidermis contain two pigments:
  + Orange-yellow carotene
  + Brown, yellow-brown, or black melanin.

1. Dermis:

* Made of tough connective tissue, allows the skin to stretch and then return to its original state.
* The dermis contains:
  + Blood vessels
  + Nerves
  + Oil glands
  + Sweat glands
  + Muscles
  + Cells that produce hair.

Hair and Nails

1. Hair

* A thread of horny material produced by special cells in the dermis.
  + Hair can be coarse or fine, straight of curly.
  + The root of the hair is alive, the rest of the strand is dead.
  + Hair grows until it’s a certain length, and then falls out. When hair falls out, a new one may grow in its place.
  + The hair contains pigment that gives it a specific color.

1. Nails

* The primary function of the nail is to protect the tips of the fingers and toes.
  + Fingernails grow three times faster than toenails.
  + The root of the nail is alive, but the rest is dead.

Skeletal System

Functions:

* Holds the body erect, and gives the body its shape.
* Attach to muscles making it possible for the body to walk, breathe, and eat.
* Bones function as levers.
* Provides protection to body organs.
* Responsible for producing blood cells, storing fat and minerals.
* Aid in hearing.

Structure:

* Comprised of 206 bones divided into two groups:
  + Axial skeleton- the skull and bones that support it.
  + Appendicular skeleton- arms, legs, and the structures associated with them.
* Cranial bones- form a case that surrounds the brain.
  + In children these bones are movable
  + In adults these bones are fixed.
  + Other bones in the skull include the cheek, nose, and jaw bones.
* Spinal column-
  + Consists of 33 bones called vertebrae. Stacked on top of one another with discs of cartilage between them.
    - Provide support for the weight of the body.
    - Allows the body to move and bend.
    - Protects a network of nerves.
* Ribs-
  + The skeleton has 12 pairs of ribs that form the rib cage.
  + Protects the heart and lungs.
  + All 12 pairs are connected in back, by hinge joints.
  + The upper seven pairs of ribs are connected in front of the breastbone, or sternum, by cartilage.
* Arms-
  + Made up of one long bone that runs from the shoulder to the elbow.
  + Two bones of the forearm.
  + Wrist bones
  + Hand bones
  + Finger bones.
  + A pair of bones joins each arm at the shoulder.
  + A long narrow collarbone connects the upper end of the breast bone with each shoulder
  + A large, flat shoulder blade is at the back of each shoulder.
* Legs-
  + One long bone that runs from the hip to the knee.
  + A knee cap that protects the knee joint.
  + The two bones that go from the knee to the ankle.
  + Ankle bones
  + Foot bones
  + And the toe bones.
* Hips-
  + The hip bones together form the pelvis and are connected to the vertebrae near the bottom.
  + The pelvis provides a firm circular support, called the pelvic girdle.
  + Pelvis allows legs to move freely.
  + In females, the girdle expands to allow childbirth.
* Joints-
  + Immovable joints- do not allow movement.
    - Ex: cranial bones, breastbone, and tailbone.
  + Partially movable- allow for slight movement
    - Ex: ribs, backbone, and pelvis.
  + Movable joints- move freely
    - Ex: hinge joints, ball and socket joint, pivot joint.
    - Bones that come together at movable joints are held together with strong bands of connective tissue called ligaments.

Materials in the Skeleton

* Bone and cartilage are types of connective tissue.
  + Bone- a large amount of hard mineral matter, especially calcium phosphate, is disposed between the cells, making it hard.
  + Cartilage- soft smooth, and flexible.
  + Growth plates- where cartilage turns into bone, causing growth in the skeleton.
* Marrow
  + Bones have a center cavity containing a soft, spongy tissue called marrow.
    - Red Marrow- found at the end of long bones. Found in the ribs, breastbone, and shoulder bones.
      * Red and white blood cells are made in the red marrow, giving red marrow its color and name.
    - Yellow Marrow- found in the shafts of long bones.
      * Yellow marrow stores fat for energy, which gives marrow the yellowish color.

Muscular System

Functions: to provide movement.

* Two types of muscles:
  + Voluntary and involuntary.
* Voluntary muscles
  + Move whenever we want them to.
  + Move bones.
  + Connected to bones with tough white cords called tendons.
  + Others connected directly to bones.
  + Some connected to other bones
    - Ex: lip muscles.
  + Cells are long and round.
* Involuntary muscles
  + Do not move voluntarily.
  + Controlled by the nervous system.
  + Movements keep us alive.
  + Cells are spindle shaped.
  + Smooth muscles.
  + Slower contractions.
* How muscles work
  + Muscles work in one way: by contracting.
  + When muscles contract they become shorter.

Nutrients

* The body’s need
  + Nutrients divided into five categories
    - Carbohydrates
    - Lipids
    - Proteins
    - Vitamins
    - Minerals
  + Contain carbon and hydrogen; categorized as organic molecules.
* Food allergies
  + Eight foods account for almost all allergies:
    - Peanuts
    - Tree nuts
    - Milk
    - Eggs
    - Wheat
    - Soy
    - Fish
    - Shell fish.
  + Symptoms:
    - Usually appear within two hours.
    - Include hives, tingling in the mouth, swelling of the tongue and throat, difficulty breathing, abdominal cramps, vomiting, diarrhea, and eczema.
    - Anaphylaxis- a sudden severe allergic reaction that involves several of these symptoms. A drop in blood pressure and loss of consciousness.
* Carbohydrates
  + Function:

Source of quick energy for all bodily functions.

* Compounds of carbon, hydrogen, and oxygen.
* Include:
  + Sugar
  + Starches
    - Ex: honey, candy, and pastry.
* Complex carbohydrates must be broken down by the body, and absorbed in the bloodstream and used in the body as glucose.
* A large amount of excess carbohydrates will transform into fat cells over time.

Lipids

* Used to supply energy.
* Build cell membranes, synthesis hormones, protect the body against injury, insulate the body against cold.
* Insoluble in water
  + Includes fats, oils, phospholipids, and cholesterol.
  + Butter, shortening, oils, salad dressings, bacon, and nuts.

Protein

* In the digestive tract, protein is broken down into amino acids.
* Amnio acids are then reunited as necessary to form various proteins.
* Meat, milk, eggs, corn, beans, and soy beans are foods rich in essential amino acids.

Vitamins

* Complex organic compounds that control or regulate certain activities in the body and are important for body growth.
* Vitamins required by humans are usually grouped into two categories
  + - Water soluble and fat-soluble.
      * Water-soluble- dissolve in the water of the blood plasma and are excreted by the kidneys.
        + Including: Vitamin B1, Vitamin B2, Vitamin B3, Vitamin B5, Vitamin B6, Vitamin B12, Biotin, Vitamin C, and folic acids.
      * Fat-soluble vitamins can be stored in body fat and can accumulate, with potential of becoming toxic to the body.
        + Including: Vitamin A, Vitamin D, Vitamin E, Vitamin K, Minerals, Water.

Amount of energy the body needs:

* The human body uses food as a source of energy.
  + - Calories are the amount of heat needed to raise the temperature of 1mililiter of water 1 degree Celsius.
    - Every bit of food is the source of a certain number of calories.
    - If a person takes in more Calories a day than the body can use, the extra energy is stored as body fat, and the person gains weight.
    - If a person takes in fewer Calories a day than the body needs, the body burns the stored fat, and the person loses weight.

Digestive System:

* Digestion
  + - For food to be used by the body it must enter the bloodstream where it is carried to the cells of the body.
    - Foods must be broken down, simplified and changed into forms that the cells can use.
  + Alimentary canal is also known as the digestive tract.
  + Digestive glands include salivary glands, liver, pancreas, gastric glands, and glands of the small intestine.

Digestion in the mouth

* The mouth starts the digestion process.
* The teeth break down the food, and start the release of nutrients.
* Most of the tooth is made of a hard, bonelike material called dentine.
* While food is being chewed, it is mixed with saliva. Saliva moistens and softens the food, making it easier to swallow.
* The tongue helps in chewing by moving the food around in the mouth.
* Food stays in the mouth for a short time, then is swallowed and enters the throat, the esophagus, and then enters the stomach.

Digestion in the stomach

* The stomach is pear shaped, located on the left side of the body below the lower ribs.
* The stomach has many glands called gastric glands.
* The stomach has powerful muscles that keep contracting and relaxing, churning the food.
* The food you eat turns into a thick, acidic liquid called chime, passes from the stomach to the small intestine, a little at a time. Then passes through a valve that opens and closes regularly about every 20 seconds.

Digestion in the small intestine

* The small intestine is the main organ for digesting food.
* While food is in the small intestine, juices from three digestive glands pour into the small intestine,
  + - The glands produce intestinal juice
    - The pancreas produces pancreatic juice.
    - Bile is a brownish-green liquid produced in the liver, bile flows from the liver into the gallbladder, where it is stored until needed.
    - An enzyme in bile breaks the fat into simpler materials, at the same time separating fat into tiny droplets.
    - Both pancreatic and intestinal juices contain various enzymes that collectively digest carbohydrates, fats, and proteins. Changing them into simpler, dissolved molecules that can enter and be used in the cells of the body.
    - After food as been digested by the small intestine it enters the blood stream through the walls of the intestine.

Osmosis

* The movement of water molecules through a cell membrane, either out of the cell or into a cell.
* Water will diffuse through the cell to the area with a lower water concentration.

Large intestine

* Food that cannot be digested or used by the body passes through the small intestine into the colon as waste material.
* The food is then transferred into waste.
* The waste is stored in the rectum for 18-24 hours and then comes out through the opening called the anus.

Cardiovascular System

* Functions:
  + - Carries digested and dissolved food to the cells in the body.
    - Brings oxygen to the cells.
    - Takes away waste materials
    - Carries germ fighting blood cells.

Blood

* Blood is a liquid tissue.
* Plasma is 90% water.
* Plasma contains salts.
* Plasma contains proteins, that helps produce blood loss during injury.
* Also has proteins that maintain osmotic pressure.
* Plasma contains antibodies, which fight disease.
* Plasma carries away waste materials.

Red Blood Cells-

* Have no nucleus.
* Can bind with oxygen
* Carries oxygen from the lungs to other cells in the body.
* Burn food
* Transports carbon dioxide out of the lungs.
* Determines blood type.

White blood cells-

* Function is to engulf pathogens or debris in tissues
* Protects the body against germs and toxins.
* Have a nucleus
* Move among the cells of the body.

Platelets

* Irregularly shaped and colorless.
* Aid in clotting blood in case of injury.
* Forms fibrin.
* Fibrin slows the flow of blood, traps the blood cells, and forms a clot that prevents the blood from escaping.

Blood Vessels

* Closed tubes that transport blood in the body.
* Arteries are blood vessels that carry blood away from the heart.
* Veins are blood vessels that carry blood back to the heart.
* Capillaries are tiny blood vessels connecting the smallest arteries and the smallest veins.

Heart-

* The heart is a muscle.
* It acts as a pump contracting and relaxing.
* The heart has two sides; the right and the left. Each side pumps blood separately from the other. The blood in the two sides does not mix.
* The heart is divided into four chambers.
  + - The top two- atria
    - The bottom two- ventricles.
      * The atria receive blood from the veins and pump it down to the ventricles. The ventricles pump blood into the arteries in the body.
  + The heart has valves that prevent the blood from flowing back into the atria.
  + The closing of the valves causes the sound of a heartbeat.

Circulation of the blood

* Two circulatory systems in the body
  + Pulmonary system
  + Systematic system
* Pulmonary system- blood flows from the heart to the lungs and returns.
* Systemic system- blood flows from the heart throughout the body and returns

Lymphatic System:

Function:

* Protects the body against infection and disease

Structure:

* Consists of the fluid lymph, network of lymphatic vessels, specialized cells (lymphocytes), and tissue and organ components integrated with other body systems
  + Ex: Appendix
    - Produces hormones necessary for regulating growth and developments of the human fetus and young children during their early years.
* Lymph passes through thin capillary walls and fills spaces between cells of the body
  + - The lymph contains digested food, water, salts, and other materials
    - Bathes the cells and supplies digested food
    - The cells give the lymph the waste products from the cells
* Lymph returns to the bloodstream through special lymph vessels
  + Collects in tiny tubes that join to form larger tubes
  + Contraction of muscles moves lymph through the vessels
  + Finally collected in two large vessels that open into two large veins just above the heart
* Lymph Nodes (enlarged lymph vessels)
  + Scattered throughout body (many are in neck, armpit, and groin)
  + Lymph tubes break into many smaller tubes again
  + The nodes contain large numbers of special white blood cells (lymphocytes: kill bacteria and other disease germs), therefore the function of nodes is to filter and purify lymph before it returns to the blood

Respiratory System:

Function:

* Bring oxygen into the body and to get rid of the waste carbon dioxide
* Cellular Respiration:
  + Breakdown of carbohydrate in the cells that produce energy
  + Cells of the body take in oxygen, use the oxygen to burn the digested food and produce heat and energy, and then give off carbon dioxide

Structure:

* Includes nose and nasal passages, the throat (pharynx), the windpipe (trachea), the voice box (larynx), the bronchi, the bronchial tubes, and the lungs
* Air enters nose through nostrils (separated by the septum)
  + Air passes through passages
  + Cilia (hairlike projections),mucus (liquid in the soft lining) trap dust and other materials & carry them to the mouth
    - End up swallowed/coughed up
* Air passes from nasal passages to throat (pharynx)
  + Two tubes in the back of throat: Gullet (esophagus: leads to stomach); Windpipe (trachea: leads to lungs)
  + Top of windpipe: flap or lid of tissue called epiglottis
    - Food/water is swallowed: epiglottis covers and closes windpipe (preventing food/water going down the windpipe
  + Epiglottis is raised during breathing (allowing air to enter the windpipe freely)
* Above epiglottis is the voice box (larynx):
  + Made of cartilage
  + Inside box: two strips of elastic tissue (vocal chords)
    - When tight, chords vibrate faster therefore pitch is higher.
    - Looser the chords, slower they vibrate, therefore lower pitch
* Trachea, esophagus, larynx:
  + Arrangement is different between humans and animal/primate.
* Bottom of windpipe divides into two branches (bronchi)
  + Each enters one lung where it divides into smaller branches (bronchial tubes)
  + Continues to branch until smallest tubes end in clusters of little air sacs (alveoli)
    - Look like tiny clusters of grapes. Each lung is one great mass of these clusters of air sacs

How We Breathe:

* Breathing
  + Mechanical process of getting air containing oxygen into lungs and getting air containing carbon dioxide out of the lungs
  + Function of respiratory system
  + Exchanges of the two gases takes place at cellular level
    - Chemical process of breaking down food to release energy (cellular respiration)
    - Artificial respiration=artificial breathing
* Air is inhaled by being forced into the lungs
  + Changes in the size of the chest cavity and changes in the air pressure of the chest cavity
  + Diaphragm (strong sheet of muscle between chest and abdomen):
    - Pulled down when muscles in it contract
    - At the same time, rib muscles contract and lift the ribs up and out
    - This increases size of chest cavity and elastic lungs expand and become larger
    - Then causes the pressure of the air in the lungs to reduce
    - Air outside the body now exerts greater pressure that the air inside the lungs.
      * Rushes into the nose, nasal passage, windpipe, and lungs to the areas of lesser pressure
* Air is exhaled when the chest cavity becomes smaller
  + Muscles in diaphragm relax, diaphragm moves up again
  + Rib muscles relax, ribs move downward and inward
  + Chest cavity becomes smaller, lungs become smaller, air is forced out of lungs and body.
* Breathing is activity of the body
  + Can take place involuntary (nerves in brain control muscles of diaphragm and ribs so breathing takes place automatically) or voluntary

Process of Gas Exchange:

* Alveoli are surrounded by millions of capillaries
  + Oxygen passes through thin walls of the alveoli/capillaries into the blood
  + Red blood cells pick up oxygen by osmotic diffusion of oxygen into the cells
    - Blood is bright red because of the oxygenated hemoglobin
  + Blood passes from lungs to heart
    - Heart pumps blood through arteries and capillaries to every part of the body
  + The cells use the oxygen to burn glucose-🡪 producing heat and energy and giving off carbon dioxide
    - Cellular Respiration: chemical process of breaking down food to release energy
    - Oxygen is required to speeds up the process
    - Breakdown of a carbohydrate:
      * Water, Carbon Dioxide, Energy
    - Energy is in the form of heat and chemical energy
      * Chemical energy is called adenosine triphosphate (ATP)
    - Some water is released with the exhaled air; some is recycled by the blood and used elsewhere in the body
    - Metabolic Rate:
      * Rate at which cellular respiration occurs
      * Amount of energy (calories) burned per hour per body surface area
      * Affected by gender (males= higher), age (decrease with age), and level of activity
      * BMR: Basal Metabolic Rate
        + Person’s metabolic rate when at rest
  + Red blood cells pick up carbon dioxide🡪blood is dark red
  + Blood passes through capillaries and veins back to the heart
  + Heart sends the carbon dioxide blood to the lungs
  + Then, carbon dioxide leaves the blood by passing through the thin walls of the capillaries and the thin walls of the air sacs into the lungs.
  + The carbon dioxide air then is forced out of the lungs
    - Fresh air containing oxygen is forced into the lungs
  + This action continues

Cell Energy Cycle:

* Cells obtain energy to do work through a special energy process
  + ALL cells contain high-energy ATP molecules
    - Result from breakdown of food
* The cell breaks the ATP down into ADP (adenosine diphosphate) and P (phosphate)
  + Energy is given off for the cell to do its work
* ADP is replenished when the cell receives glucose from digested food.
  + Glucose combines with oxygen🡪 giving off energy
  + Energy changes ADP and P back to ATP again
* Average adult uses more than 45 kilograms (100 pounds) of ATP every day

Urinary System:

Body Wastes and Their Elimination from the Body

* Various waste materials is produced by the body
  + Carbon dioxide, water, digestive juices, mineral salts and nitrogen compounds (cells, tissues, muscles wear out or break down), undigested and unused foods
* Body gets rid of the waste materials in different ways
  + Lungs give off carbon dioxide & some water in the form of water vapor
  + Skin gives off perspiration (water, dissolved mineral salts)
  + Solid undigested wastes are passed through the digestive tract and eliminated as feces during defecation
  + Some liquid and dissolved solid wastes are filtered from bloodstream and eliminated through urinary system.

Kidneys and the Structure of the Urinary System

* Kidneys play important part in removal of waste materials
  + Kidneys are two dark-red, bean-shaped organs
    - Located in lower part of the back
  + Each is packed with millions of tiny tubes (nephrons)
    - Functioning filtering units of kidneys
  + Nephrons filter from the blood wastes such as mineral salts and protein compounds
    - Form a liquid called urine
  + Urine flows from each kidney through a tube (ureter) to urinary bladder
  + Then urine is voluntarily removed through a tube (urethra)

Nervous System:

Function and Parts of the Nervous System

* Function:
  + Controls the action of the muscles and other tissues
  + Controls the actions of the sense organs
  + Controls the action of thinking, learning, memory, and many human behaviors
* Parts:
  + Central:
    - Brain and spinal cord
  + Other:
    - Nerves

Brain

* Located inside skull (protected)
  + Most highly specialized organ in the body
  + Control center of the body
  + Receives messages from all parts of the body and sending out orders in return
  + Surface has many folds
* Three main parts:
  + Cerebrum:
    - Largest part of the brain
    - Located at the front and top
    - Made up of two halves that are firmly joined together
    - Left side controls movement of right side of body (vise versa)
    - Functions:
      * Controls thinking, reasoning, learning, memory, and imagination
      * Recieves messages from sense organs and recognizes them as smell, taste, touch, pressure, sight, hearing, heat, cold, and pain
      * Controls voluntary movement of the muscles in the body
  + Cerebellum:
    - Located behind cerebrum.
    - Coordinates movements of the muscles so they operate together smoothly (walking)
    - Helps body to keep sense of balance
  + Medulla:
    - Located at the base of the brain
    - Joins top of spinal cord
    - Controls the operation of involuntary muscles
      * Heart action, breathing, digestion, coughing, and sneezing

Spinal Cord

* Connected to the brain’s medulla
* Long rod of nerve tissue going down almost the whole length of the backbone
* 31 pairs of nerves branch off the spinal cord and connect the brain with the rest of the body
* If cord is cut, no nerves operate below the point where it was cut
  + All parts of the body controlled by the nerves are paralyzed

Nerves

* Cells of nervous system (neurons)
  + Vary in size and shape
  + Carry messages called nerve impulses through the body
* Every neuron has a cell body & many fine threads (nerve fibers) that spread out through the body
  + One fiber (axon): long and carries messages away FROM cell body
  + Other fibers (dendrites): short and carry messages TO cell body
  + Both branch many times at tips making the tips look like tiny brushes
* Bodies of the nerve cells lie in the brain and spinal cord
* Nerve fibers run to the head, trunk, feel, and other parts of body
* Three kinds of neurons:
  + Sensory
    - Carry impulses for feelings/sensations
    - Cell bodies usually lie in the brain and spinal cord
    - Nerve fibers spread out to sense all organs all over the body
    - Nerve fibers carry messages from the sense organs to bodies
    - Nerve impulse flows someone like an electrical current but is actually a process of biochemical reactions
  + Motor
    - Carry impulses that produce motion in the body
    - Their cello bodies usually lie in the brain and spinal cord
    - Nerve fibers spread out to the muscles, tissues, and organs
    - Never fibers carry messages from the cell bodies to the muscles, tissues, and organs
  + Associative
    - Also called central neutrons
    - Located between cell bodies of the sensory and motor neurons
      * Act as go-betweens in receiving and sending messages
    - Both cell bodies and nerve fibers of associative neurons are usually located in the brain and spinal cord.
* All neutrons are involved in receiving and sending messages
  + Nerve fibers in the sense organs all over the body carry messages to the cell bodies of the sensory neurons
  + Sensory neurons send messages through nerve fibers to cell bodies of associative neurons🡪 transfer messages through nerve fibers to cell bodies of motor neurons
  + Cell bodies of motor neurons then send messages through nerve fibers to muscles, tissues, and organs

Reflex Action

* Action of the body that takes place automatically or involuntarily without thinking about it
  + Nerve impulses travel only to the spinal cord and back to area involved (without going to brain)
  + Example on page 405
* Medulla of the brain controls reflex actions like swallowing, coughing, and sneezing

Special Senses

* Nervous system makes it possible for the human body to have many sensations
  + Different sensory nerves located in special sense organs send nerve impulses.
    - Touch, pressure, heat, cold, pain, smell, taste, sight, hearing, and balance
  + Come from 5 sense organs:
    - Skin, nose, tongue, eyes, and ears
* The skin has 5 kinds of sensory nerve endings
  + Touch, pressure, heat, cold, pain
  + Sensory nerves are not spread out evenly over the skin 🡪skin is more sensitive in some places than in others
    - Fingertips and forehead have many nerve endings sensitive to touch
    - Never endings sensitive to touch are near surface; those sensitive to pressure are deeper
* Sense of smell is located in the nose
  + Nerve endings in nose are sensitive to chemicals in air
  + When inhaled, chemicals dissolve in liquid (mucus)
  + Nose smells same odor for long time, nerve endings become accustomed/sensitized to that odor and sensation of smell for that odor ceases
* Sensation of taste is located in clusters of cells (taste buds) that are spread unevenly over tongue
  + Taste buds at tip of tongue: sensitive to sweet/salty flavors
  + “ sides of tongue: Sour flavors
  + “ back of tongue: Bitter flavors
* Sense of sight is located in the eye
  + Protected by bones of the skull on all sides (except front 🡪 eyelids)
  + Eyelids close/blink to protect the front
    - Help spread a watery liquid across surface of the eye.
      * Keeps it moist
      * Protects against germs
      * Washes out dirt
  + Eyeball:
    - Tight, white cover around it
      * Small part of covering: Cornea
        + Transparent (light can pass through)
      * Cornea covers dark opening: Pupil
        + Allows light to pass
      * Circle around pupil: Iris
        + Controls amount of light entering the eye
        + Muscles of iris change the size of pupil, depending on light intensity
        + Bright light= enlarged iris
        + Dim light= narrow iris
  + Inside the eye:
    - Convex lens and two liquids
    - In front of lens: Aqueous humor
    - Behind: Vitreous humor
    - With help from liquids, lens bends the rays of light as they enter the eye
      * Causes rays of light to come together to focus on sensitive lining (retina)
    - Retina has sensitive nerve endings that lead to the optic nerve
    - When light strikes retina, nerves send impulses through the optic nerve to the brain
      * Impulses are interpreted as sensation of sight
  + Inside Retina:
    - Two types of neurons
      * Cones and rods
    - Cones allows us to see objects in bright light and to recognize color
    - Rods allow us to see objects in dim light and to detect brightness
* Adjustments must be made to allow a clear focus at varying distances
  + Muscles attached to the lens can make the lens more/less convex
  + The muscles allow the rays of light come together at the retina
  + When an object is far away, the lens becomes thinner/less convex
    - Rays of light from distant object do not have to be bent as much to focus at the retina
  + When an object is near, lens becomes thicker or more convex
    - The rays of light from nearer object must be bent more to focus at the retina
  + The image formed on the retina is upside down
    - But the brain is able to invert the image or to interpret this message as right side up
    - Because we have two eyes🡪 we get two images
      * The brain is able to put together as one image
      * Provides depth reception
  + The eye is able to retain the image of an object for a little while after light from the object is no longer entering the eye
    - Persistence of Vision
    - Motion Pictures
  + Most animals/humans can hear a much broader frequency range than they can produce
    - For humans, sense of hearing is located in the ear
      * Outer ear, inner ear, middle ear
      * Outer ear collects sound waves and sends them through a tube to the middle ear
        + Thin piece of tissue (membrane) is stretched across the end of the tube
        + Sound waves strike the eardrum and cause it to vibrate
        + The higher the sounds🡪 faster eardrum vibrates
        + Louder the sounds🡪 more strongly the eardrum vibrates
      * Middle ear passes vibrations to inner ear
        + Middle ear has 3 small bones:

Hammer- connected to eardrum

Anvil-connects hammer to stirrup

Stirrup- connected to inner ear by another membrane (oval window)

* + - * Inner ear consists of a spiral passage (cochlea)
        + Shaped like a snail’s shell and filled with liquid
        + When the oval window of the inner ear vibrates, liquid inside cochlea also begin to vibrate
        + Tiny nerve endings in the cochlea receive vibrations and send nerve impulses to auditory nerve
        + Nerve relays the impulses to the brain where they are translated as sound
      * Inner ear contains 3 tubes
        + Curve around in half circles: Semicircular canals
      * Canals are laid out in 3 directions (head can move up down, sideways)
        + Filled with watery liquid that moves when the head moves
        + Nerve endings line the walls of the canals

When the head moves, liquid in one canal rushes to one end and presses on the nerve endings

This pressure causes nerve impulses to travel through a branch of auditory nerve to cerebellum of the brain

Cerebellum sends a message to the muscles that helps keep balance

Reproductive System:

* Function and Parts
  + Primary Function:
    - Continue the species by producing offspring
  + Male Reproductive System
    - Produces sperm
    - Delivers cells to reproductive tract of the female
    - Produces male sex hormones (androgens)
      * Androgens are responsible for development of the male secondary sex characteristics (facial axillary, pubic hair, lower voice, broad shoulders, narrow hips, growth of penis/testes)
      * Sperm cells (spermatozoa) are produced continuously in the coiled tubules in the two testes
      * Testes lie outside pelvic cavity in a sac (scrotum)
      * Leaving the testes, sperm cells pass through sperm duct (vas deferens)
      * Vas deferens: secretions are added to the sperm cells from four glands (seminal vesicles, prostate, ampulla, bulbourethral gland). The fluid makes semen
      * Mucous membranes line the canal adding lubricant to semen
      * Semen is passed through urethra and out of the body through the penis
  + Female Reproductive System
    - Three functions:
      * Produces egg cells (ova)
      * Secretes the female sex hormones (estrogens/progesterones)
      * Protects and nourishes the developing embryo from fertilization until birth
    - Egg cells are developed in the ovaries
      * One located on each side of the lower part of the abdominal cavity
      * Ovaries are surrounded by funnel-like extensions of the oviducts (fallopian tubes)
      * Oviducts are connected posteriorly to a pear-shaped organ (uterus)
      * Embryo grows in the uterus
      * Lower part of the uterus: Thick muscular ring (cervix)
      * Cervix extends partially into the birth canal (vagina)
  + Beginning with puberty:
    - Eggs are released from ovaries (One egg from one ovary about every 28 days)
      * Uterine lining thickens, readying for an egg
      * If fertilization occurs, egg implants and grows
      * If does not, uterine lining sheds
      * Menstrual cycle
    - Release of egg is controlled by hormones released from the pituitary gland in the brain
      * Pituitary gland secretes a follicle stimulating hormone (FSH) that causes cells around egg to develop a sac or follicle (produces estrogen)
    - Estrogen:
      * Causes development of primary (sex organs)/secondary (wider pelvis, smoother skin, breasts, thicker layer of fat beneath skin) female sex characteristics.
      * Regulates FSH production by pituitary
      * Stimulates pituitary to release luteinizing hormone (LH) (breaks follicle and release egg \*ovulation\*)
    - Ovulation:
      * Remaining cells of broken follicle develop into new/temporary gland (corpus luteum)
      * Corpus luteum produces progesterone (helps prepare lining of uterus for embryo if egg is fertilized)
      * If fertilization does not offur: 10 days later the luteum breaks down
      * Flow lasts about 5 days
    - Fertilization:
      * Takes place in upper third of oviduct.
      * Sperm cells deposited in vagina by penis
      * Helped along by contractions of uterus and oviduct, sperm swim to oviduct
      * Sperm cells move quickly, entering oviducts within 15 minutes after semen entered
      * Egg cell lives only for a day after emerging ovaries. Sperm cells live up to two days.
      * If fertilized: Egg (zygote) moves down oviduct to uterus. Once attached the placenta forms.
        + Composed of tissue from both mother and embryo
        + Allows for exchange of nutrients and wastes between baby and mother.
        + Produces hormones that stimulate production of progesterone to keep lining of the uterus from being shed.
* Our Inheritance
  + Many of our characteristics are inherited by biological parents
  + No individual organism lives forever, reproduction is essential to the continuation of the species.
    - Females produce eggs, males produce sperm.
    - Egg and sperm unite: Zygote develops
    - Zygotes had equal contribution of genetic information from each of parents.
    - Sexually reproduced offspring are never identical to parents.
  + Organism requires set of instructions for specifying traits:
    - Heredity is passage of the instructions from one generation to next
    - Genetic information is contained in genes
      * Each gene carries a single unit of instruction
    - Genes are small sections of DNA
      * Mutation is a change that can affect one gene or entire chromosomes.
  + Gender is determined by two chromosomes (X and Y)
    - Female: Pair of X chromosomes
    - Male: X inherited by mother and Y inherited by father
  + Inherited Traits: Dominant and Recessive
    - Dominant: One chromosome to inherit trait; tongue curling, free-hanging earlobes, Huntington’s disease
    - Recessive: Two chromosomes; Most genetic disorders
  + International Human Genome Project
    - Mapping genetic makeup of human chromosomes
    - Identification of genes and genetics tests for disease susceptibility offers a chance for preventive action (can extend life expectancy)

Endocrine System:

* Structure and Function
  + Directs changes in other organ systems
    - Carries out function by producing chemical secretions from glands that make up the system and are carried by blood to other parts of body.
    - Glands are organs whose gives off secretions that have special uses in the body.
      * Tubes (with ducts) and without ducts
      * Glands with ducts
        + Exocrine glands
        + Give off secretions that travel through ducts to body parts they affect
        + Salivary glands in the mouth and the sweat and oil glands in skin
        + Digestive juices that help digest foods in body are given off by duct glands in stomach, the intestine, the pancreas, and liver
      * Glands without ducts
        + Ductless glands (Endocrine glands)
        + Give off hormones
        + Hormones pass through walls of capillaries into blood and travel to different parts of body

Regulate the body’s activities

* + - * + Organs: Pituitary gland, hypothalamus, thyroid gland, parathyroid glands, pancreas, adrenal glands, thymus gland, heart, kidney, digestive tract, male testes, female ovaries
* Pituitary Gland and Hypothalamus
  + Pituitary gland (hypophysis)
    - Tiny gland attached to base of brain
    - Secretes 10 different hormones and sometimes referred to master gland
      * Some hormones affect or regulate activity of almost all other glands; other hormones affect activity of kidneys/blood vessels
    - If gland is overactive during childhood/adulthood
      * Child will grow up well beyond average size
      * Adult’s jaws, nose, hands, and fingers will become large
      * Vice versa for underactive
  + Hypothalamus secretes hormones that regulate and integrate nervous and endocrine systems.
* Thyroid and Parathyroid Glands
  + Thyroid Gland:
    - Looks like a butterfly with wings spread and located below voice box on windpipe
    - Gives off hormone: Thyroxine (controls speed or rate of metabolism)
  + Parathyroid:
    - Four small glands on back of thyroid
    - Secrete parathormone, controls use of calcium in body
* Pancreas
  + Duct gland and ductless gland
  + Located behind stomach adjacent to duodenum
  + Gives off pancreatic juice (helps digestion of food in small intestine)
  + Scattered throughout pancreas:
    - Small groups of cells (islets of Langerhans) which are ductless glands that produce hormone insulin.
  + Insulin regulates use and storage of sugar in the body
    - Body digests food, carbs are broken down into simple sugars (glucose)
    - Cells in body use oxygen to burn some glucose to produce heat and energy in ATP
    - What glucose isn’t used is stored in liver until needed
    - When pancreas does not produce enough insulin, diabetes is developed
    - Liver then cannot store sugar and cannot be used efficiently
    - Muscles and tissues cannot get the sugar needed, blood becomes flooded with sugar
    - Person loses weight, urinates often, very thristy
    - Some excess sugar passes through urine
    - People with diabetes are given insulin regularly by injection.
      * Given pills to help bodies release more of own insulin
      * Special diet
    - Can occur in children and adults
      * Children:
        + Caused by viral infection or autoimmune reaction to person with genetic predisposition

Autoimmune reaction is one which body’s immune system attacks own tissue as if they were foreign.

* + - * Adults:
        + Higher than normal amount of insulin as well as sugar in the blood because the pancreas is producing insulin normally but the body cells are resistant to insulin
* Adrenal Glands
  + Two small glands located on top of the kidneys
  + Outer layer of adrenal glands gives off many hormones
    - Control digestion of food and regulate balance of salt and water in body
  + Inner layer gives off hormone (adrenaline)
    - Angry/Frightened: Adrenal glands respond quickly and pour adrenaline into the blood
    - Adrenaline makes heart beat faster, makes blood pressure rise, makes digestion show down
    - Causes breathing to become faster and deeper
    - Causes liver to send more of its stored sugar to the blood
    - Drives more blood into vessels in deeper muscles
    - Makes blood clot more easily and quickly